An In-Circuit Component Tester

Simple oscilloscope accessory speeds up in-circuit testing of resistors, capacitors, inductors, and transistor and diode junctions

By William R. Hoffman

Designing and building electronic circuits is both challenging and fun to do. However, when a circuit or piece of equipment attached to it suddenly fails to function, troubleshooting it can be anything but fun. This is especially so if the circuit is complex and nothing has obviously happened to give a hint of the problem's cause. In some cases, the troubleshooting procedure may require that the components in the circuit be individually tested. This is a very lengthy and frustrating job, and the components can be damaged if they must be removed from the circuit for testing.

An obvious solution to the dilemma is to use some kind of tester that allows the components to be individually tested *without* removing them from the circuit. Fortunately, such test equipment does, indeed, exist. Presented here, for example, is a simple accessory device you use with any oscilloscope that has X-Y capability. With the In-Circuit Component Tester to be described, you will be able to generate a recognizable trace pattern on the scope's CRT for each common type of component. The displayed pattern can show when a component is open or shorted, as well as when it is functioning properly. Though this is called an "in-circuit" tester, it can be used to test individual components out-of-circuit as well.

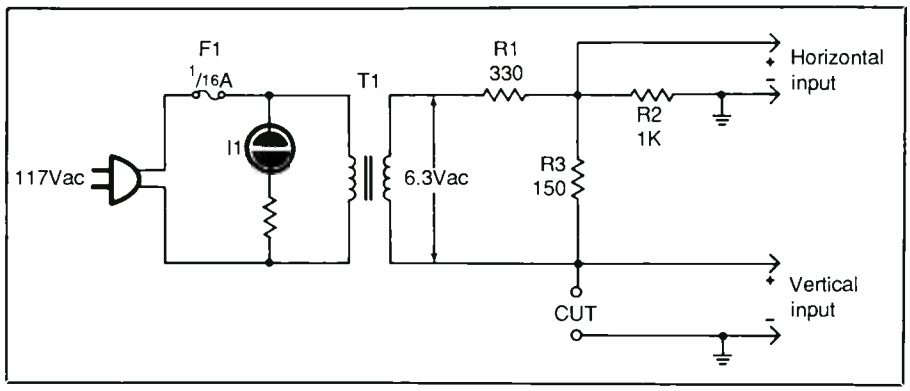

Fig. 1. Overall schematic diagram of In-Circuit Component Tester.

About the Circuit

The schematic diagram of the In-Circuit Component Tester accessory is shown in Fig. 1. This is simply a bridge-type circuit that supplies a test signal of about 2.5 volts ac rms at 60 Hz to the component under test (CUT). This signal allows you to make a comparison between the component being tested and a reference known good component.

Shown in Fig. 2 are some of the typical trace patterns that can be displayed on the scope CRT being used with the In-Circuit Component Tester. Note here that with good components, both a capacitor and an inductor will produce a loop in the trace, which is a consequence of the internal voltage-current phase shifts of these components. Also, any normal semiconductor (diode or transistor) junction will generate a trace that is

PARTS LIST

F1—1/16-ampere, 250 volt fuse
I1—Panel-mount 117-volt ac neon-lamp assembly with built-in limiting resistor
R1—330-ohm, ¼-watt, 5% tolerance resistor
R2—1,000-ohm, ¼-watt, 5% tolerance resistor (see text)
R3—150-ohm, ¼-watt, 5% tolerance resistor
T1—6.3-volt power transformer
Misc.—Small metal box; terminal strips (2); fuse holder; ac line cord with plug; output cables with connectors to match scope inputs; test leads; machine hardware; hookup wire; solder; etc.

flat horizontally and rises to the right or left, depending on the polarity of the test leads. Because it has no reactance, a resistor will produce only a straight diagonal line. The angle of the line (and the loop if any) generated depends on the value of the inductor, capacitor or resistor being tested.

Feel free to experiment with the value of *R2* in this Tester, or have resistors with different values between which you can switch as desired. As a general rule, increasing the value of *R2* will make measuring of small values of inductance and capacitance much easier to perform. Conversely, decreasing the value of *R2* permits more accurate testing of large-value electrolytic capacitors and large-value inductors.

With the value of *R2* set to 1,000 ohms, the capabilities of the Tester are substantial. Some of the component types and values you can test include:

•*Capacitors* over a range of values from about 0.05 to 200 microfarads. By raising *R2*'s value to 10,000 ohms, the range of values that can be checked changes to about 5,000 picofarads to 20 microfarads. This is enough of a range to check most capacitors in modern solid-state circuits. The CRT display for a good capacitor is shown in Fig. 2(A).

•*Inductors* (and transformer windings) can be tested over a range of about 200 microhenries to 2 henries, which covers just about any inductance you are likely to encounter in today's circuits, including the values of power filters. The CRT display for a good inductor is shown in Fig. 2(B).

•*Resistors* display a straight diagonal line whose angle is a function of resistance, as shown in Fig. 2(C). This line's angle will vary from horizontal at 10 ohms or less to vertical at about 100,000 ohms. Potentiometers can be tested by connecting the Tester's probes to either outer and the center lug and varying the control shaft from stop to stop. As you do this, the diagonal-line trace should vary very smoothly over a range of angles to horizontal at minimum resistance. If the trace jumps around as the control shaft is rotated, the pot's wiper contact or resistive element is dirty or bad.

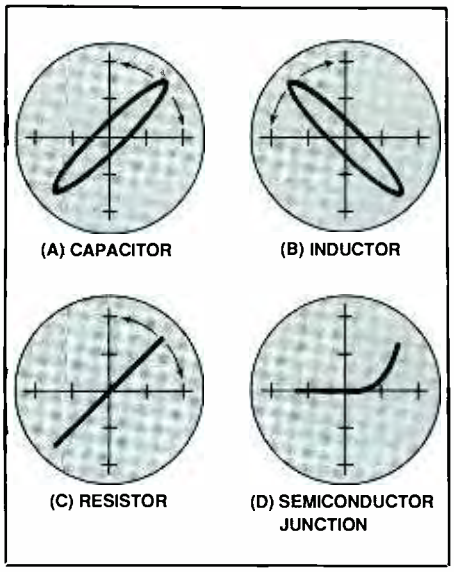

Fig. 2. Typical scope displays obtained for the most common circuit components. Traces shown are for good components. Departures from these indicate that the component being tested is defective.

•*Semiconductor Junctions* of any good diode, transistor or JFET will cause the distinctive trace shown in Fig. 2(D) to be displayed. If a junction is shorted or open, only a horizontal or vertical line will result.

If any component being tested is short-circuited, the scope trace will simply be a flat horizontal line. Should a component become open-circuited, a straight vertical line will be displayed. Bear in mind, too, that since most circuits have components that are in parallel with other components, you can obtain a scope display that is a combination of the traces shown in Fig. 2 during testing. By following your troubleshooting on the circuit's schematic diagram as you perform the individual tests, you will see that the component being checked is properly connected with the other circuit elements.

Construction

Because of the Tester's simple circuitry, printed-circuit or other types of board wiring is unnecessary. The prototype for this project was built in a small metal box. All components were mounted on two terminal strips. If you prefer, you can build the circuit into a spare corner of your oscilloscope, assuming there is enough room for it, for the ultimate in compactness and neatness.

If you mount the Tester circuit inside a separate metal box, be sure to line the entry hole for the ac line cord with a rubber grommet. Otherwise, the sharp edges of the hole can cut through the cord's insulation and create a hazardous condition.

Using the Tester

Plug the In-Circuit Component Tester's line cord into an ac receptacle and connect the test cables to the scope's vertical and horizontal inputs. With a 1,000-ohm resistor connected across the CUT terminals, adjust scope sensitivity and trace positioning so that the CRT displays a flat diagonal line centered on the zero axes of the X and Y graticule lines. This trace should slope upward from lower-left to upper-right, as in Fig. 2(C). You can now proceed with using the Tester. No other calibration or adjustment is needed.

Once you become familiar with the Tester, it will become obvious why so many professionals and hobbyists have come to rely so heavily on it for speedy troubleshooting. In complex circuits, some users have reported as much as a 90% reduction in troubleshooting time! Now you, too, can take advantage of this powerful, simple troubleshooting tool.